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A GEOLOGIC SECTION IN THE CENTER OF THE SAN JOAQUIN VALLEY, CALIFORNIA*

BY

J. A. TAFF & G. D. HANNA

Associated and Pacific Oil Companies

During 1925 the Associated and Pacific Oil Companies drilled three deep test wells in the flat plain of San Joaquin Valley, where the sequence of strata has long been more or less a matter of general speculation. The wells and their locations are as follows:

WELL No.	LOCATION	DEPTH
1	Sec. 26, T. 15, R. 18 (13 miles S. W. of Fresno)	6042'
1	Sec. 14, T. 15, R. 18 (12 miles S. W. of Fresno)	6884'
1	Sec. 35, T. 13, R. 16 (23 miles west of Fresno)	5737'

Careful records were kept throughout the drilling; rotary equipment and efficient core-barrels were the means whereby a very large number of uncontaminated samples of formations were obtained. A study of these samples has enabled us to reconstruct the section with as great, and probably greater accuracy than if it had to be made from surface exposures.

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Some difference in sequence was found in the three localities. For instance, the Santa Margarita Miocene was found in the well on Section 35 at 3267-3275 feet; on Section 14, at 3954-3963 feet; on Section 26 at 4352 feet. This and later data show that there is a progressive rising of the strata to the northward, which has no indication on the surface.

The formation known as "Big Blue" on the west side of the valley, was identified in all three wells. On Section 26, it was 600 feet thick; on Section 14, 850 feet thick; and on Section 35, 762 feet thick.

The lower part of the Miocene differed very much in the well on Section 35, from the other two by having strata, aggregating 200 feet which contained organic shales; this condition was not found in the wells on Sections 14 and 26, and it is very improbable that it could have been present and missed, considering the thoroughness with which the coring was done. This again illustrates the elusiveness of bedded sands and shales in valley Miocene.

Definite Eocene rocks were struck in all three wells, and the upper contact has been placed at 4973 feet on Section 35; at 5619 feet on Section 14; and at 5658 feet on Section 26. None of the wells passed out of this formation.

Details of the sections in each well follow:

Well No. 1, Sec. 26, T. 15 S., R. 18 E., M. D. M.

Fine-grained shales, sandy shale and coarse sand, gray to brown in color and without organisms were found, from the surface to 4352 feet. At 4226 feet some fragmentary Mollusca were found which were thought to be Etchegoin in age.

At 4352 feet definite Santa Margarita strata were encountered, which contained distinctive pectens, oysters and barnacles. The formation consisted in the main of medium grained sands with only occasional layers of non-fossiliferous shale.

At 4691 feet there was entered a zone of dark blue to green, fine-grained clay shale, occasionally becoming a tough chocolate-brown, massive, clay shale. Sometimes these two colors were curiously mixed in the bedding. The material was proba-

bly derived from erosion of land areas of serpentine. No fossils were found in it except near the base in this well where a few imperfect impressions of diatoms were seen. The formation so agrees in lithology and position with what has been called "Big Blue" in the Coalinga region that we felt safe in making that correlation. Toward the base the formation became more and more sandy.

At 5292 feet a fine grained gray sandstone was struck. Some succeeding layers were of unconsolidated sand, varying in coarseness and consolidation from place to place, and at 5480 feet there was definite conglomerate.

This 200 feet of decidedly arenaceous sediments was succeeded at 5508 feet by clay shales again. The color of these was various shades of blue, green and brown, sometimes variegated in the same sample. Fossils were practically absent.

At 5658 feet there was a decided change in the sedimentation. Greenish gray, coarse grained sandstone, with numerous imperfect remains of what appeared to be fossil algæ was found. This indicated lagoon conditions so prevalent in the Eocene that we were convinced here was the beginning of rocks of this age. This determination was corroborated at 5770 feet by the finding of some corals which appeared to belong to a common Eocene species. At this depth and below, there was much tan and buff colored clay shale. It continued with few interruptions to the bottom of the well, at 6042 feet. Some of this shale, and possibly a great deal, was in the nature of tuff, but did not appear to have been laid down on land. Dips which appeared to be reliable were found as steep as 20°. Above the Eocene the strata were practically horizontal.

A recapitulation of the section of this well is as follows :

Alluvium, Tulare and Etchegoin Pliocene formations from the surface to 4352' ;

Santa Margarita Miocene from 4352' to 4691' ;

"Big Blue" Miocene from 4691' to 5292' ;

Probably Vaqueros sands from 5292' to 5508' ;

Undifferentiated clay shales from 5508' to 5658' ;

Eocene sands and shales 5658' to 6042'.

Associated Oil Company

Well No. 1, Sec. 14, T. 15 S., R. 18 E., M. D. M.

This well offsets one which is known as Fresno United No. 2, drilled by the Fresno United Oil Company, and in which there was found at about 4000 feet definite Santa Margarita Mollusca.

The Associated well was carefully cored and reached the depth of 6857 feet. Bit and ditch samples were collected from a depth of 350 feet to 3534 feet, and, while they were non-fossiliferous, they resembled so closely material from the Tulare and Etchegoin elsewhere in the San Joaquin Valley that such classification was considered reliable. A line of demarcation between the two could not be definitely drawn.

Fine and coarse grained sandstone, sometimes poorly consolidated, was found from 3810 to 3963 feet, where the first fossils were encountered. These were barnacles and oysters of unquestionable Santa Margarita age.

From 3963 feet the color of the sandstones varied from blue and brown to gray; at 4135 and 4248 feet, there were numerous fossil leaves and at 4210 feet a piece of a crab. The last Santa Margarita fossils were found at 4353 feet.

From 4353 to 5206 feet the sediments consisted chiefly of blue, green and brown fine-grained clay shales, with occasionally some layers of sand, especially in the lower part. Some of the cores had vari-colored clays in one sample. They appeared to have been derived from erosion of serpentine land areas and the whole formation was considered to be "Big Blue."

At 5206 feet a conglomerate was found, some of the igneous pebbles of which were one-and-one-half inches in diameter. Vari-colored sands and sandy shales continued downward to 5338 feet.

From 5349 to 5555 feet there was a continuous bed of greenish gray and brown shale, sometimes variegated in the same sample.

At 5555 to 5581 feet there was conglomerate with pebbles up to one inch in diameter. The pebbles were composed of various metamorphic and igneous rocks. Various sands and sandy shales continued to 5670 feet.

At 5670 feet there appeared a coarse grained, buff colored sandstone; buff and tan sands, interbedded with greenish and brownish clay shales continued downward to 6332 feet.

At 6360 feet there appeared a hard dark brown, thinly laminated shale, with numerous foraminifera of definite Eocene age. The dip changed between these two formations from about 10° to about 25°, indicating a decided angular unconformity.

Glauconite and Eocene fish scales were found at 6500 feet where the dip became about 45°. This layer of shale continued downward to 6604 feet. At 6634 feet there was a dark olive gray shale which at 6673 feet had definite Eocene Mollusca.

Dark gray sandstones and sandy shales and clay shales continued from 6634 feet to the bottom of the well at 6884 feet.

A recapitulation of the section of this well is as follows:

Alluvium, Tulare and Etchegoin Pliocene from the surface down to 3963';

Santa Margarita Miocene, 3963' to 4353';

"Big Blue" Miocene, 4353' to 5206';

Vaqueros? sands, 5206' to 5338';

Undifferentiated clay shales, 5349' to 5555';

Undifferentiated conglomerates and sands probably the base of the Miocene, 5555' to 5670';

Undifferentiated sands and clays, probably Eocene, 5670' to 6332';

Thinly bedded, tough, foraminiferal Eocene shales, 6360' to 6604';

Eocene sands, 6634' to 6884'.

Associated Oil Co.

Well No. 1, Sec. 35, T. 13 S., R. 16 E., M. D. M.

(Herminghaus)

Bit and core samples were taken in this well from 1837 to 3162 feet the material passed through being various kinds of shale and sandy shale of probably Tulare age. This was followed by about 50 feet of gray sands which may have been Etchegoin.

At 3267 feet the first fossils were found, and these proved to be Santa Margarita oysters. Coarse grained sandstone

continued down to 3520 feet. It was followed at 3538 feet by a diatomaceous clay shale, which continued to 3552 feet. This shale was unquestionably Miocene in age.

At 3588 feet gray sandstones began, which continued interrupted only by sandy shales and clay shales of the same color, to 3967 feet.

The "Big Blue" began at 3992 feet and as usual was composed of massively bedded green, blue and brown clay shales, sometimes variegated in the same sample. At 4217 to 4225 feet, an interbedded olive gray clay shale contained numerous Miocene diatoms. The "Big Blue" continued with only slight variations to 4744 feet.

From 4772 to 4973 feet there was found a deposit of very organic, dark brown, thinly bedded shale. Diatoms, foraminifera and fish remains were abundant. A petroleum residue was found in these samples. The organisms contained in this deposit were of Miocene age, and it is believed to be the equivalent of the diatomaceous shale north of Coalinga, below the Vaqueros Reef and above the Eocene sands. This usually goes under the name of "Kreyenhagen Shale," but appears to be an integral part of the Miocene and certainly not the same as the Kreyenhagen Shale at the type locality on Canoas Creek; this latter is Eocene. In none of the Miocene strata outlined above was a dip of more than 5° found.

At 4981 feet a gray sandstone was struck, evidently the top of the Eocene. At 5014 feet a common Eocene *Turritella* and numerous Foraminifera and Mollusca were found in a greenish gray sandy shale. Much glauconite existed in this immediate vicinity and the texture of the rocks was very similar to the outcrops of Eocene shales in Marysville Buttes. Very fossiliferous strata continued downward, there being numerous layers with much carbonized wood and other plant remains. The last sample came from 5737 feet and showed no indication of a change in formation.

A recapitulation of the section of this well is as follows:

Alluvium, Tulare and Etchegoin Pliocene from surface down to 3235';

Santa Margarita Miocene, 3267' to 3520';
Miocene Shale, 3538' to 3552';
Undifferentiated Miocene sands, 3588' to 3967';
"Big Blue" Miocene, 3992' to 4744';
Lower Miocene diatomaceous shales, 4772' to 4973';
Eocene sands, sandy shales and clay shales, 4981' to 5737'.

After the foregoing report was in proof a fourth well was completed in this general region. It was Associated Oil Company Well No. 1, Sec. 36, T. 13 S., R. 16 E., M. D. M., (Herminghaus) and about half a mile northeast of the one last considered above. Excellent confirmation of the geologic section was obtained. Lower Miocene diatomaceous shales were found from 4790' to 5024', after which Eocene sands and shales with many characteristic fossils were found to the bottom of the well at 5078'.

It will be noted from the above that the siliceous shales just above the Eocene have been called "lower Miocene." This is done because they have not been definitely identified with the formation on the west side of the San Joaquin Valley mapped as "Kreyenhagen" by Anderson and Pack¹ and questionably referred by them to the "Oligocene."

¹ U. S. Geol. Surv. Bull. 603, 1915.